The Effect of Immediate and Delayed Platelet-Rich Plasma Treatment on Muscle Contusion Healing in the Rat

Demetris Delos MD¹, Matthew Leineweber MS², Salma Chaudhury MD, PhD¹, Saif Alzoobazae BS¹, Yingxin Gao PhD², Scott A. Rodeo MD¹

¹Hospital for Special Surgery, New York, NY; ²Sibley School of Mechanical and Aerospace Engineering, Cornell University, Ithaca, NY

No conflicts of interest to report

INTRODUCTION

Muscle contusions are among the most common injuries in sport. Current therapy is usually limited to NSAIDs and/or use of the RICE principle (rest, ice, compression, elevation). Other forms of treatment that can potentially accelerate the rate of healing are desirable. This study seeks to investigate the effects of platelet-rich plasma (PRP) on muscle contusion healing in rats and to determine if the timing of injection plays any role in recovery.

MATERIALS AND METHODS

STUDY DESIGN

Forty-six (46) male Lewis rats each underwent a single blunt impact to the gastrocnemius muscle via a dropmass technique. The rats were separated into 4 groups, as follows:

- Rats in Group 1 (n=11) underwent a single injection of 100ul of saline within 2 hours of injury (CTRL-CONTROLS)
- Rats in Group 2 (n=12) underwent a single injection of 100ul of rat PRP within 2 hours of injury (PRP 0)
- Rats in Group 3 (n=12) underwent a single injection of 100ul rat PRP on post-injury day #1 (PRP 1)
- Rats in Group 4 (n=11) underwent a single injection of 100ul of saline within 2 hours of injury (CTRL-PRP)

After the injury, rats were allowed unlimited activity. The primary outcome measurement was maximal isometric torque strength of the injured muscle, which was performed prior to injury as well as on post-injury days 1, 4, 7, 10, and 14. All animals were sacrificed on post-injury day 15.

Histologic analysis was performed using hematoxylin and eosin (H and E) to determine the number of centronucleated muscle cells (marker of muscle regeneration) and Masson Trichrome to evaluate fibrosis.

RESULTS

Platelet and Growth Factor Concentrations

Mean PRP platelet concentration was 2.19x10⁹ ±2.69x10⁹ per ul, which was over 4 times greater than mean whole-blood platelet levels. Levels of PDGF, VEGF, and TGF-beta were increased by factors of 2.6, 1.8 and 2.7, respectively, compared to whole blood levels.

Isometric Torque Testing

Each group demonstrated statistically significant decreases in maximal isometric torque strength after injury (compared to pre-injury levels — see Figure 3), followed by significant increases back towards baseline values by post-injury day 14. There were no statistically significant differences between the treatment and control groups at any of the time-points.

Histologic Analysis

Histologic analysis also revealed no statistically significant differences between any of the groups (figures 4A and 4B).

MATERIALS AND METHODS (continued)

PRP Production

Whole blood was drawn from Lewis rats via intracardial puncture following euthanization by CO₂. The blood was pooled and centrifuged at 1000g for 30 minutes at 4°C. The platelet rich fraction of the supernatant was then isolated.

Biomechanical Testing (Maximal Isometric Torque)

The rat was sedated and placed supine on a custom platform with the foot secured onto a foot plate. Muscle stimulation was performed using monopolar needle electrodes. Contraction was induced by stimulation with a 15 mA constant current and voltage was optimized for maximum contraction.

CONCLUSIONS

This experiment demonstrated that rat PRP with a concentration of platelets to greater than 4 times baseline whole blood levels (whether administered immediately or in delayed fashion) failed to show any benefit in terms of functional or histologic outcomes.

Possible limitations associated with this study are:

- The optimal concentration of platelets, timing of injection, and volume of solution to be injected has not been determined
- It is still unclear what the role of leukocytes in PRP is
- The potential benefits of PRP for acute muscle healing may be limited — it may be that chronic injuries/lesions respond better than acute ones.

LITERATURE CITED


ACKNOWLEDGMENTS

American Orthopaedic Society for Sports Medicine (AOSSM) Young Investigator Award (2010-2012); Rudin Foundation Grant Award